Written Reply

To Mr. Hiroshi YAMAMURA, Examiner at the Patent Office

1. Identification of the International Application
PCT/JP99/02910

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5. Contents of this Argument

(1) We have received the opinion in accordance with §13 Japanese Law Concerning the International Application of the Patent Cooperation Treaty and Related Matters (PCT rule 66), and would like to respond with the following argument.

(2) Claims 1, and 9-12

The invention of claim 1 satisfies the following conditional expressions (a) and (b):

$Yt>Y$ ... (a)

$(Y/Yt)/(f/ft)<1.5$ ...(b)

where Y is a movement amount of a third lens group at a focal length f of an entire system when correcting camera shake, Yt is a movement amount of the third lens group at a telephoto end, and ft is a focal length of the telephoto end.

Assuming that camera shake correction of ±0.45° at the maximum is

carried out at the telephoto end by a 12:1 power zoom, the camera shake, being experimentally calculated, corresponds to camera shake while walking. In this case, the maximum movement amount of the lens/lenses for correcting camera shake (a third lens group) corresponds to Yt in the expression (a). When the movement amount of the correcting lens is fixed, an image on an image plane moves further as the angle is changed from the telephoto angle to the wide angle.

Therefore, Y is set to be smaller than Yt in expression (a), and the correcting lens at the wide-angle side is set to move less, so that an appropriate correcting angle is secured.

More specifically, since an angle of view is narrow in the vicinity of the telephoto end (e.g., from an 8:1 power zoom position to the telephoto end), the image may move unnaturally or deterioration in the performance may be noticeable when the image movement exceeds a range set at the telephoto end. Such an unfavorable matter occurs, for example, in a correction of a range exceeding an actual camera shake of ±0.45° as mentioned above.

An image moves on an image plane by correcting camera shake with the lens. However, the movement amount on the image plane may be greater than that of actual camera shake as the angle of view is narrowed (approaching to the telephoto end). Therefore, caution should be taken to prevent the image from moving excessively at a zooming position in the vicinity of the telephoto end.

An appropriate correction amount should be secured previously in the vicinity of the telephoto end, however, the correction amount will be increased more than needed if the movement amount of the correcting lens is fixed. For example, the maximum range for camera shake is actually ±0.70° (camera shake on a car). When the movement amount Y of a correcting lens group at a certain zooming position is made the closest to Yt, a correction amount is ±0.70° at a position of an 8:1 zoom for a 12:1 power zoom.

In other words, correction amount is increased more than needed at a position of 8:1 zoom or closer to a wide-angle side. In such a case, Y can be set to be smaller than Yt as in the expression (a) in order to decrease the movement amount of the correcting lens at the wide-angle side and to secure an appropriate correcting angle.

The attached FIGs. (A) and (B) are to compare the movement of images for respective zooming positions when the movement amount of a correcting lens group is fixed. In a comparison between FIGs. (A) and (B),

movement of an image will be less noticeable for a wide-angle end when compared to a telephoto end because the angle of view is enlarged at a wide-angle side. However, in the wide-angle side shown in FIG. (B), the relative position of the image is shifted further after a move. Images will be moved excessively as the angle becomes wide. Only satisfying the condition of the expression (a) is not sufficient for preventing such an excessive move.

For solving this problem, the expression (b) shows a condition for a wide angle of view. In the expression (b), amount of camera shake at each zooming position is determined to be less than 1.5 times of the amount of correcting camera shake at the telephoto end.

When correction of ±0.45° is carried out at a telephoto end of a 12:1 power zoom lens as mentioned above, an acceptable amount of correcting camera shake at the respective zooming positions is smaller than 1.5 times of the telephoto end, i.e., smaller than ±0.70° (camera shake on a car).

The attached FIG. (C) is a graph indicating the expressions (a) and (b) where the x-axis means a focal length f and the y-axis means the maximum movement amount Y of the correcting lens. The right side of the x-axis represents telephoto position. The shaded portion represents a range to satisfy the expressions (a) and (b), i.e., an optimum range for correction.

At a position having a narrow angle of view with an 8:1 to 12:1 power zoom, the figure will not exceed the range of ±0.7° within the expression (a), and thus, camera shake can be corrected in a natural manner. At a position having wide angle of view at a position from a wide-angle end to an 8:1 power position, the figure will vary up to only ±0.7° within a range to satisfy the expression (b). Therefore, camera shake can be corrected in an appropriate range for use. Namely, since the invention of the claim 1 satisfies both the expressions (a) and (b), camera shake can be corrected in a natural manner in the whole range from the wide-angle end to the telephoto end.

In an examination on the invention described in the reference 1, the respective data in the Example 1 shown in Table 1 (p.6) are as follows.

Focal length at a wide-angle end (fw)=72.165

Focal length at a telephoto end (ft)=290.048

Movement amount (Y) of the third lens group at a wide-angle end =0.30

Movement amount (Yt) of the third lens group at a telephoto end =0.60

An equation of (Y/Yt)/(fw/ft)=2.01 is obtained from these data, and

this shows that Example 1 does not satisfy the relationship of the expression (b) in the present claim 1.

In addition to that, the zooming ratio in Example 1 is as small as about 4 power, and an acceptable range for camera shake is different from what is predicted in the present claim 1. Therefore, in Example 1, problems explained in the present claim 1 are not apparent. Example 1 does not show any technical ideas to correct camera shake in a natural manner in the whole range from the wide-angle to the telephoto end by controlling the amount in correction of the third lens group in a certain range.

Regarding the lens structure, Example 1 describes that the first, second and fourth lens groups can move in the optical axis direction during zooming and focusing, which is quite different from the structure of the present claim 1.

The following are the respective data of Example 2 described in Table 2 (pages 7-8) of the reference 1.

Focal length at a wide-angle end (fw)=4.98

Focal length at a telephoto end (ft)=37.56

Movement amount (Y) of the third lens group at a wide-angle end =0.20

Movement amount (Yt) of the third lens group at a telephoto end =0.20

In Example 2, zooming is conducted in the same manner as the present claim 1. However, the data results in equations of Yt=Y and (Y/Yt)/(fw/ft) =7.54, i.e., Example 2 does not satisfy the relationship of the expressions (a) and (b) in the present claim 1. The value is especially removed from the expression (b).

In a calculation result based on an angle of view, height and movement amount of an image shown in Example 2, the amount of camera shake correction at the telephoto end is ± 0.29° and the amount of camera shake correction at the wide-angle end is ± 2.04°.

In such a case of a normal camera shake (± 0.45° at walking and ± 0.70° in a car), overcorrection will occur due to the correction amount of ± 2.04° at the wide-angle end in Example 2, and the correction will be quite unnatural. Unlike the claimed invention described in claim 1, Example 2 does not include any technological ideas to secure appropriate correction angles by decreasing movement amount of a correcting lens when the focal length has a wide angle.

Moreover, the invention described in the reference 2 does not include a correcting lens group moving vertically to an optical axis. It has no description or suggestion about the expressions (a) or (b).

Unlike the invention of present claim 1, neither the reference 1 or 2 shows technical ideas to provide natural correction of camera shake in the whole range from the wide-angle end to the telephoto end by controlling the correction amount of the third lens group in a certain range. These references have no description on zoom lenses satisfying the expressions (a) and (b). Therefore, it is not obvious for a person skilled in the art to obtain the invention of claim 1 from the references 1 and 2, and thus, the invention of the present claim 1 and claims 9-12 dependent on the claim should have an inventive step.

(3) Claims 13, 14, 16, 17, 20-23, 28 and 29

As described in an attached amendment, amended claim 13 is combined with original claim 24 that has been regarded as inventive, so that claim 13 also can be considered as having an inventive step. Similarly, claims 14, 16, 17, 20-23, 28 and 29 dependent on the amended claim 13 can be considered as having an inventive step.

(3) Claims 30-35

The invention of the present claim 30 satisfies the relationship of the expressions (a) and (b) as in the invention of claim 1. Effects relating to the expressions (a) and (b) are the as same the explanation about claim 1. Therefore, the invention described in claim 30 and that described in claims 31-35 dependent on claim 30 can be considered as having an inventive step.

(4) Claim 36

Claim 36 has been added as described in the attached amendment. The disclosed zoom lens comprises four lens groups, where the third lens group is composed of three lenses and the fourth lens group is composed of one positive lens. This is disclosed in p.42, line 22, p.51, line 6, p.57, line 1, p.62, line 3, FIGs. 17, 24, 29, 34 and 39 in the original description (written in Japanese), so no new matters are added. Invention of the newly-added claim 36 depends on claim 30, and it can be considered as having an inventive step.

(5) Claims 37-41

As described in the attached amendment, claims 37-40 are original claims 19, 25-27 that is added in an independent form, since these claims are regarded as inventive. The newly-added claims, therefore, can be considered as inventive. The invention of claim 41 dependent on claims 37-40 also can be considered as inventive.

6. List of attached document

Explanatory figures of the present invention 1 sheet

Description based on the provision of PCT 19(1) (PCT Rule 46.4)

The amended claim 1 is based on the original claim 1, combined with claims 3 and 6-8. The newly added claim 30 is based on the original claim 1, combined with claims 4 and 6-8. With this amendment, shapes and numbers of the lenses of the third and fourth lens groups are limited, and the relationship between the focal length and the movement amount of the third lens group is also limited.

Unlike the present invention, the cited document (JP-A-7-199124) has no disclosure or suggestion about a zoom lens to satisfy the relationship of $Yt>Y$ and $(Y/Yt)/(f/ft)<1.5$. A zoom lens according to the present invention, satisfying the above-mentioned relations, can prevent deterioration in the optical performance when correcting camera shake.

The amended claim 13 is obtained by incorporating claim 15 into the original claim 13. This amendment limits the refracting power of the third and fourth lens groups, and clarifies that the lens for correcting camera shake is the third lens group. Unlike the present invention, the cited document (JP-A-7-128619) has no disclosure or suggestion that the refracting power of the third and fourth lens groups are positive and negative respectively, and that the lens for correcting camera shake is the third lens group. A zoom lens in the present invention comprises a fourth lens group with a negative refracting power, and a long back focus can be obtained easily.